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vegetables every year for twenty years, and has eighty head of cattle and thirty-five horses.

The beautiful valley of the Clearwater River, near the 57th parallel is covered with pea vine, vetch, red-top, and upland hay, growing in profusion. It will, in Mr. Crean's opinion, make a magnificent cattle range and farming country. There are large open prairies, the grass is fine and the soil is a good loam, with a sandy clay subsoil. When the railroad now planned reaches McMurray on the Athabaska, there is no doubt that a large agricultural settlement will take possession of this fine valley.

The statements here reproduced from Mr. Crean's report are sufficient to show that, in all probability, Canada has a large reserve for settlement in the territory to the north of the lands now surveyed in Alberta and Saskatchewan. Before many years this great region will have steam connections with the settled regions to the south, and then the utilization of the northern territory will begin. There is little doubt that in the near future this part of Canada will be the home of thousands of farmers and stock raisers.

NOTES ON THE DESCRIPTION OF LAND FORMS.—IV.

Wellington Harbor, New Zealand. By what method can a scientific observer who has seen and studied a certain district give the best account of it to a scientific reader who has not seen it? The method followed in some essays is to begin with an empirical description of the observed facts, arranged in order of their distribution and phrased in popular language, and then on a later page, after some account of the geology of the district has been given, to present the geographical facts again, but this time in genetic order and in technical, explanatory phrase. Yet the very author who follows this two-fold method in his geographical presentation may in the same essay introduce his geological matter immediately in thoroughly technical style. Perhaps the reason for the adoption of methods so unlike for the two sciences is a semi-conscious feeling that geography is not yet ripe for so advanced a treatment as is proper in geology; that geographical descriptions must be at least introduced in an empirical and popular form, even if they are intended for readers who can at once understand geological technicalities, and who can on a later page than the first understand geographical technicalities also.

Anyone who has had experience in discussing problems of this kind with geographical authors differing in temperament and training must know that preferences as to method and style vary over a wide range. It is probable that some readers of these notes will prefer, even in articles for trained readers of scientific journals, that geographical presentation should be made in the two-fold method, first empirical and then, after some geological pages, explanatory; they may not approve of the more direct method which introduces explanations promptly at the beginning, by giving as terse and technical an explanatory outline of the whole story as is consistent with ready reading, and then devoting to the presentation of additional details the space that the other method occupies with duplicate statements.

While I have no desire to conceal my own preference for direct and technical presentation in scientific journals—whatever other methods may be preferred for elementary schools or for popular lectures—it is not at all my wish to imply that there is anything like a right or wrong way of proceeding; nor is the least my intention to impugn the value of the results presented in the two-fold method. The matter that I wish to place before the readers of the BULLETIN is that conscious and intentional experiments should be made in the use of various methods of description before any one method is adopted; and that the best one of many possible methods should be then selected for use, always with due consideration of the space at the author's disposal and of the class of readers addressed. If conscious experiment of this kind is not made, the writer's preference may be based on habit accidentally formed before acquaintance was gained with various alternative methods, rather than on careful choice after abundant trial. It is the making of an open-minded choice of method that is here urged. Only after such choice is made should habit be formed.

In order to give specific illustration of the question at issue as regards the two-fold and the direct method of geographical description, I may cite an article on "The Physiography of Wellington Harbor," by my friend, J. M. Bell, Director of the Geological Survey of New Zealand (*Trans.* N. Z. Inst., xlii, 1909, 534-540). The article bears internal evidence of being based on careful observation from which well considered theoretical conclusions are derived, and after one has read it through a clear picture of an interesting district is gained. There can hardly be two opinions on these points, although as the article is unfortunately only six pages long, there is not space enough for the full presentation of all the facts on which the conclusions are grounded. The value of the article is evident. The question here raised concerns only the kind of presentation from which the mature geographical reader shall most readily acquire a clear understanding of the district that is treated. Its chief conclusions are as follows:

Wellington Harbor—or Port Nicholson as it is often called—is a land-locked body of water, measuring nine miles north and south by five miles east and west, which opens southward at the southern end of the northern island of

New Zealand. It results from the irregular displacement of several north-south fault blocks, the fragments of an extensive peneplain that had, in an earlier cycle of erosion, been worn down on folded argillites and grauwackes. The uplifted blocks, now maturely dissected and in some places subdued, form ridges and highlands on the east, north and west. The depressed and submerged blocks determine the irregular area of the harbor. The eastern border is comparatively simple, as if it followed a nearly straight scarp between the uplifted and depressed areas. The harbor mouth is narrowed to a mile on the southeast by the non-submerged southern part of two western ridge-blocks which farther north dip under water; thus the inner harbor gains its full width of five miles; but it is here and there interrupted by islets and shoals, as if the depressed blocks were incompletely drowned. The eastern one of the two ridges by which the harbor mouth is narrowed seems at first to have been an island, but it is now attached to its western neighbor by a sand isthmus which divides what was originally a second entrance to the harbor into a short outer and a longer inner bay. The oblique inner or northwestern border of the harbor is the scarp of a northeast-southwest master fault, still so steep and so little dissected that the streams from the highland have not yet incised their narrow gorges to its base; below the gorge mouths the streams plunge down in abrupt waterfaults. [It is here to be regretted that the narrow limits of the article excluded statement of the relation between the strike of the folded strata and the trend of the inferred master fault, for in case these two directions diverge the evidence of faulting would be much stronger than if they were parallel.] Since the time of displacement, the original northeastern extension of the harbor has been much reduced by the delta of Hutt river, which, broadening as it grew forward, has at present a frontal width of nearly two and one-half miles. In the same period, strong but immature sea cliffs have been cut on the southern slope of the exposed fault blocks along the outer coast; and less pronounced shore work has been done around the protected coast line of the harbor. Very recently a slight elevation, partly accomplished during the earthquake of 1855, has revealed a narrow strip of the marine platform forward from the cliffs of the outer coast, and has laid bare some flats well adapted for settlement around the border of the harbor. Wellington is partly built on one of these flats on the west, where the full width of the harbor is gained between the partly submerged blocks on the south and the scarp of the oblique master fault on the north.

Even without the aid of the outline map which accompanies the original article, the reader ought to gain a fairly good idea of Wellington harbor from this explanatory description, which is compiled from Bell's statement with a few changes of phraseology. Each element of the description suggests a definite and easily conceived form. A peneplain worn on folded argillites and grauwackes is readily pictured. The divisions of the peneplain into fault blocks, generally trending north and south, and the displacement of the blocks in a specified manner, with the resulting submergence of the harbor area, offer no difficulty of understanding. The mature dissection of the uplifted blocks is very readily imagined. The filling of part of the harbor area by the forward growth of Hutt river delta, the carving of great and small sea cliffs on the outer and inner coast lines, and the building of a sand isthmus between the partly submerged ridges are additional consequences of normal and marine agencies in the cycle of erosion introduced by the displacement. The revelation of the wave-cut platform in front of the outer cliffs and of flats around the harbor border is a simple result of recent elevation. [No mention is made of terraces in the delta.] All of this explanatory matter is indeed so plain that one may understand it at the first reading; but it is from the later, not from the earlier, pages of Bell's paper that the explanatory statements are taken. If we omit certain local details and local names, and paraphrase a few words, his first page reads as follows:

"The harbor is a fine sheet of water about nine miles long by five miles wide, land locked save at a comparatively narrow entrance. . . . A number of islets and two small islands . . . . appear on its surface, while several shoals . . . . render navigation somewhat difficult in places. High hills almost completely surround the harbor, rising in general in steep slopes from the water's edge. There are, however, several fair sized areas and small patches of level or gradually sloping land close to the edge of the harbor. By far the largest of these is that which forms the relatively wide valley of the Hutt river, extending northeastwards from the northeastern end of the harbor. This plain has a width of nearly two miles and a half near the harbor, and gradually narrows as it extends inland. Westward from the narrow [entrance of the harbor] is a low range of hills. . . . These are connected with . . . . [a second range of] hills, to the west, by a narrow sand isthmus between . . . . . and . . . . . bays. The [hills of the second range] . . . . attain their maximum altitude in Mt. . . . . . which rises some 648 ft. above the sea. To their westward is the low and relatively flat land on which the city of Wellington stands, having a slope on the northern side to the harbor and on the southern side to . . . . . bay. Westward of the city rise the . . . . . hills. These are partially separated by the . . . . . valley from the main range of hills extending northeastwards along the edge of the harbor and bordering the Hutt valley to the westward. A view from any prominent position on the hills around . . . . [the harbor] discloses an elevated country stretching in all directions, broken by narrow valleys and deep ravines. If this elevated country be viewed from a point on the eastern side of the harbor, one is struck with the general uniformity in height attained by the crests of the various hills on the west side. Since this even skyline is quite independent of the structure of the country rocks, which consist of highly folded and shattered argillites and grauwackes, it apparently exhibits an elevated plain of erosion, or peneplain."

Only after this empirical introduction do we find in three and one-half pages, devoted partly to geological history, partly to physiographic evolution, the statements from which the explanatory account of the harbor as given above is condensed. The local names of various hills and bays are omitted above, in order to emphasize the fact that they have no descriptive value whatever for a reader who does not know the district concerned.

The empirical quality of the introduction is maintained with remarkable faithfulness, even to treating forms so easily understood as a river delta and an island-tying sand isthmus in terms independent of their manifest origin. But is it helpful to the mature reader to proceed so cautiously? Is it really worth while to be so deliberate as to allow three pages of text to intervene between the empirical statement of immediately observable facts regarding a delta and a sand isthmus, and the simple explanation of their origin. Is it desirable to insert nearly a page of geological history between the empirical description of the harbor and the explanatory account of it as a submerged graben? In answering these questions the reader should bear in mind that, when the argillites and grauwackes are first mentioned, their present condition is described at once in explanatory fashion by the phrase, "highly folded and shattered"; that is, their deformed structure is presented not in empirical terms of direct observations, but in genetic terms that are indicative of the inferred processes, which, according to current geological theory, have produced it.

Again, such terms as anticline and syncline, paleozoic and mesozoic, are used without introduction, on the perfectly reasonable assumption that the readers to whom the article is addressed will immediately understand them. Yet so elementary a conception as a delta or a peneplain is approached empirically and inductively, as if it were unknown, or as if the interpretation that it implies were hazardous. There is perhaps an appearance of safety in an inductive presentation of this kind; but surely the manner in which a result is presented has nothing to do with its safety. That important quality depends on the care in observation and the skill in theorizing that were exercised during the investigation that precedes presentation. The correspondingly important quality in presentation is clearness, with which the deliberate pace of induction and the paraphrases of empirical description are not necessarily associated.

An experimental test of the relative efficiency of the two-fold and the direct methods may be made fairly well, if a geographical reader of these notes will ask some patient and geographically minded friend to listen while the empirical and the explanatory descriptions, as given above, are read to him; and then to express his opinion on the advantage of introducing the explanatory by the empirical statement, as compared with entering at once upon the explanatory statement: but the experiment can be better made if the geographically minded reader will try the two methods of procedure for himself, when he next has occasion to write an article of his own.

W. M. Davis.